

SOUTHWEST RESEARCH INSTITUTE

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April 30, 1996

*INTERIM
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6/1/61*

Mr. Larry J. Early
Code 840
GSFC/Wallops Flight Facility
Wallops Island, VA 23337

Re: Annual Report on Grant NAG5-5005, SwRI Project 15-5647, "SPS, Langmuir Probe, and Data Analysis for Aerospace Magnetospheric/Thermospheric Coupling Rocket Program"

Dear Mr. Early:

In this letter, I describe work done under the above grant during the third year.

BACKGROUND

Grant NAG5-5005 was awarded to provide two instruments and a small amount of data analysis for the rocket flights of Aerospace Corporation's coordinated study of magnetospheric/thermospheric coupling and dynamics of the auroral upper atmosphere. The instruments are a Soft Particle Spectrometer (SPS) and a Langmuir Probe. The SPS is a divergent plate electrostatic analyzer of the type flown on the Dynamics Explorers and UARS and will measure simultaneously the differential spectra of electrons and ions incident on the upper atmosphere. The Langmuir Probe is a small spherical probe with accompanying electronics to sweep its potential above and below the spacecraft potential and measure the current to it, yielding ambient ionospheric temperature and densities. Both instruments have now flown successfully on the flights of ARIA 1, 2, 3, and 4.

ACCOMPLISHMENTS

In September of 1995 (between the ARIA 3 and 4 flights), the SPS was sent to the University of Saskatchewan to be calibrated in the laboratory of Dr. D. McEwen, a member of the ARIA team and P.I. of the SEA (Soft Electron Analyzer). The SPS was calibrated in the low-energy range of 10 eV to 400 eV. The instrument was returned to SwRI for final check-out before sending it to Aerospace in preparation for the ARIA 4 launch trip.



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ARIA 4 was launched on November 27, 1995, at 0807:24 UT into a stable midnight-sector diffuse aurora. The payload systems performed well. Data from the SPS are shown in Figure 1. The top panel shows the electrons which have a broadly peaked spectrum, having a characteristic energy ~ 4 keV initially, decreasing gradually as the payload moved northward to about 2 keV. The only structure in the electron population is seen between 0811:46 and 0812:58 UT (corresponding to an altitude range of 234 and 203 km). It may be associated with either waves or a potential structure above this location and will be investigated further.

Positive ions are shown in the second panel. At instrument turn-on, they had characteristic energies of 20-30 keV which decreased throughout the course of the flight to about 10 keV. As with the electrons, the ions decreased in intensity throughout the flight.

Because of the stable nature of the precipitation at the time of the ARIA 4 flight, this is an excellent data set for studying the relationships between particle energy input and subsequent atmospheric effects such as the production of secondary electrons and auroral optical emissions. Initial results of such a study are the subject of a Spring AGU paper, Strickland et al. (1996-see below).

Examination of the SPS after the ARIA 4 flight indicated difficulty with either the re-entry or the landing of the payload or both. In numerous locations on some of the coated internal surfaces, there were pinpoint sized spots that visually contrasted with the otherwise relatively uniform gray of the Aquadag coating. These were examined under an optical microscope with two types of illumination. Conclusions were that the spots were corrosion products that had erupted through the Aquadag coating. It is speculated that moisture accumulated in the cavity behind the cover, either by direct entry of liquid water or, more likely, by condensation of atmospheric humidity. If this occurred, then surface impurities would have been activated by the presence of moisture, leading to corrosion at sites where a crack or thin spot in the Aquadag coating overlaid a fault in the Alodine finish.

The investigation suggests (a) that we undergo more stringent handling procedures, particularly in preparing the Alodined surfaces for Aquadag treatment, and (b) that in future launch campaigns more attention be given to keeping the payload dry as it is being transported from the impact site back to the launch site.

In spite of the rough re-entry and landing of ARIA 4, post-flight calibration at SwRI indicated essentially no change in SPS calibrations between the ARIA 3 pre-flight calibrations of February 7, 1995, and the ARIA 4 post-flight calibrations done on January 6, 1996. The same channel multipliers were used on both flights and, in fact, were not removed from the SPS between flights.

Dr. Sharber attended a data analysis and planning meeting at Aerospace Corporation on February 2 and 3, 1996.

Analysis of data from the flights of ARIA 2, 3, and 4 has resulted in four papers presented at the AGU. The papers are listed in the following section.

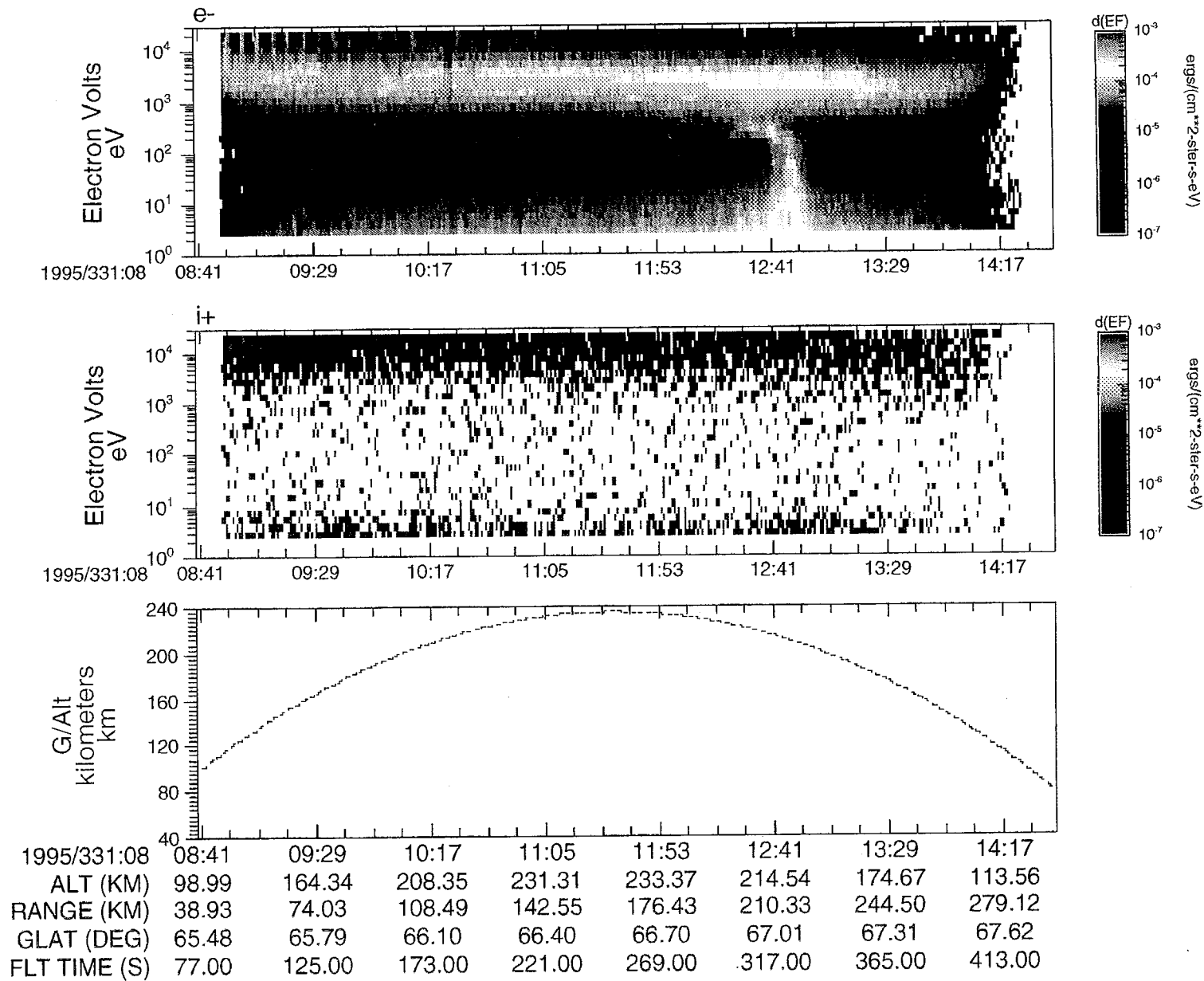


Figure 1. Particle data from the Soft Particle Spectrometer (SPS) measured during the flight of ARIA 4 on November 27, 1995. The electrons (top panel) have a broadly peaked spectrum with characteristic energy of ~4 keV decreasing to about 2 keV as the payload moved northward across the premidnight diffuse form. The only structure in the electron population is seen between 0811:46 and 0812:58 UT and may be associated with waves or a potential structure at this location. At SPS turn-on the ions (second panel) had characteristic energies of 20-30 keV which decreased to about 10 keV near the end of the flight. The lower panel shows a plot of altitude and is annotated below with altitude, horizontal range, geographic latitude and flight time.

A no-cost 6-month extension has been granted in order to continue work on AGU talks and publications based on flight data from the ARIA flights. The work reported in the AGU papers listed below will be published in several publications, similar to what was done with ARIA 1.

Publications and Presentations

The following papers will be presented at the 1996 Spring AGU Meeting.

"Substorm Associated Particle and Joule Heating in the Aurora," P.C. Anderson, A.B. Christensen, J.H. Hecht, J.R. Sharber, and D.J. Strickland, presented at the American Geophysical Union, Spring Annual Meeting, abstract in EOS Spring Supplement, S189, 1996.

"Rocket and Ground-Based Measurements of Composition Change in the Lower Thermosphere Near Poker Flat Alaska During the ARIA Rocket Flights," J.H. Hecht, A.B. Christensen, D.J. Strickland, and J.R. Sharber, presented at the American Geophysical Union, Spring Annual Meeting, abstract in EOS Spring Supplement, S189, 1996.

"A Comparison of Observed and Optically Inferred Neutral Atmospheric Scale Heights During the ARIA/Kayser-II Rocket Flight," P.R. Straus, J.H. Hecht, A.B. Christensen, J.R. Sharber, and D.J. Strickland, presented at the American Geophysical Union, Spring Annual Meeting, abstract in EOS Spring Supplement, S190, 1996.

"Analysis of Particle and Zenith Viewing Optical Data from the ARIA I and IV Auroral Rocket Experiments," D.J. Strickland, T. Majeed, J.H. Hecht, A.B. Christensen, and J.R. Sharber, presented at the American Geophysical Union, Spring Annual Meeting, abstract in EOS Spring Supplement, S190, 1996.

The following papers were published in the September, 1995 issue of the *Journal of Geophysical Research*:

"The ARIA I Rocket Campaign," P.C. Anderson, A.B. Christensen, J.R. Sharber, P.R. Straus, J.H. Hecht, M.F. Larsen, D.C. Kayser, D.J. McEwen, W.E. Sharp, J.A. Koehler, G.G. Sivjee, L.R. Lyons, D.J. Gutierrez, and J.D. Winningham, *J. Geophys. Res.*, **100**, 17265-17283, 1995.

"Observations of the Neutral Atmosphere Between 100 and 200 km Using ARIA Rocketborne and Ground-Based Instruments," J.H. Hecht, A.B. Christensen, D.J. Gutierrez, D.C. Kayser, W.E. Sharp, J.R. Sharber, J.D. Winningham, R.A. Frahm, D.J. Strickland, and D.J. McEwen, *J. Geophys. Res.*, **100**, 17285-17298, 1995.

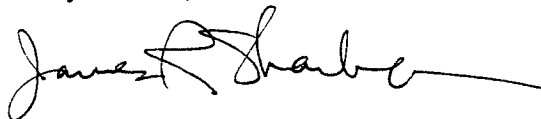
"E-Region Neutral Zonal Winds in the Post-Midnight Diffuse Aurora During the ARIA I Rocket Campaign," D.G. Brinkman, R.L. Walterscheid, L.R. Lyons, D.C. Kayser, A.B. Christensen, J.R. Sharber, R.A. Frahm, M.F. Larsen, *J. Geophys. Res.*, **100**, 17309-17320, 1995.

PLANS FOR NEXT SIX MONTHS

During the next six months work will continue preparations for the AGU meeting and publications based on the AGU papers. A final technical report will be submitted on October 31, 1996, the end of the extension period.

If you have further questions, I may be reached at the above address or by phone at 210-522-3853.

Very sincerely,

A handwritten signature in black ink, appearing to read "James R. Sharber", with a long horizontal flourish extending to the right.

James R. Sharber
Department of Space Science

:mfa
Enclosure

cc: Dr. M. Mellott/NASA HQ